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Motion Amplification: A New Way to Visualize Vibrations

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Jeff Hay, PhD, CEO RDI Technologies

- Interests in Photography
- PhD in Applied Optical Physics
- Started research in Astronomy
- Originally developed optical technology for bridge measurements

Motion Amplification

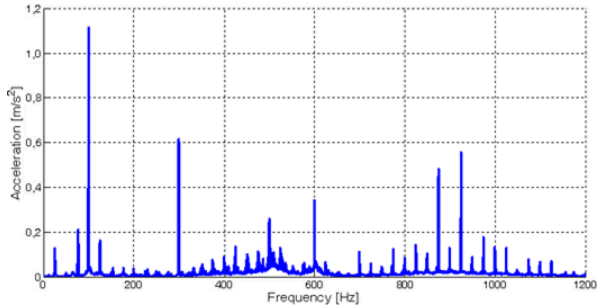
Motion Amplification utilizes a camera to turn each pixel into a displacement sensor capable of measuring vibrations and amplifying them to a level visible to the eye. This capability lends itself to an advanced troubleshooting tool for routine inspection and root cause analysis.

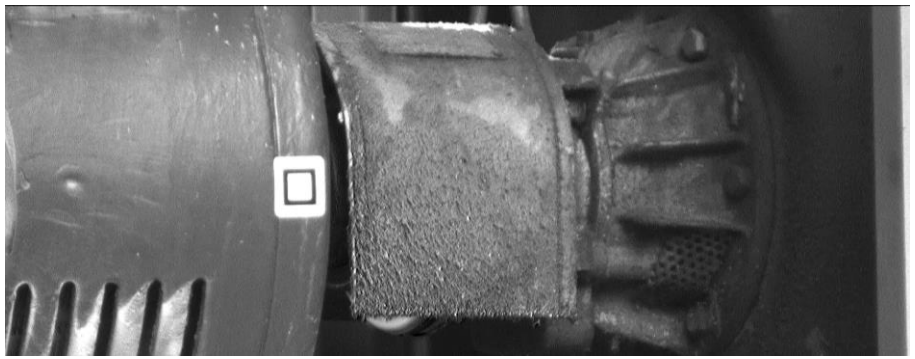
A case study will highlight how the technology has been applied to solve a long standing critical motor stator pump issue at a power generation facility. Before and after video will demonstrate the results after corrective action.

What is Motion Amplification

Technology Overview

- Measure movement not visible to the human eye.
- Technology turns every pixel in the camera's view into a sensor
- The results lend themselves to a visualization of the motion.
- We can measure and quantify any structure or assets that a camera can see.



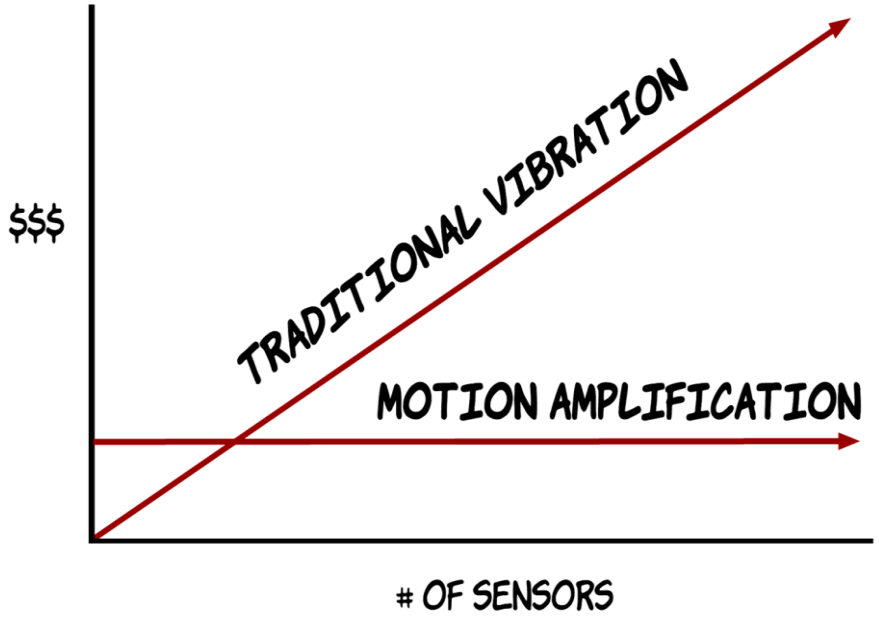


Technical Specifications

- Fundamental Measurement is Displacement
- 0.1 mils with 50 mm lens at 1 meter
- Up to 650 Hz in frequency at reduced resolution
- Timing accuracy of 1 μs
- 2 – axis measurement orthogonal to line of sight
- Synchronous measurement across image

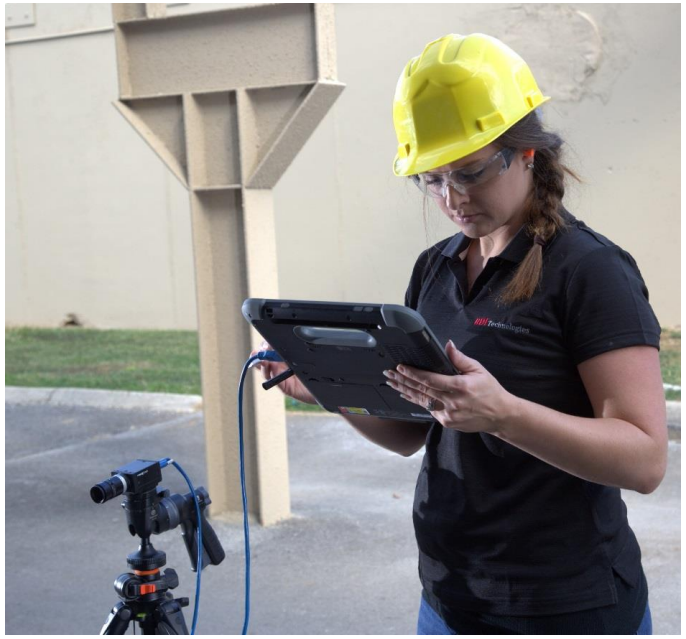
See the Big Picture

- Traditional Vibration is limited by cost and access to sensors
- Motion Amplification allows you to scale data collection without adding cost
- Visualize the entire asset in one collection



Simple and Easy to Use

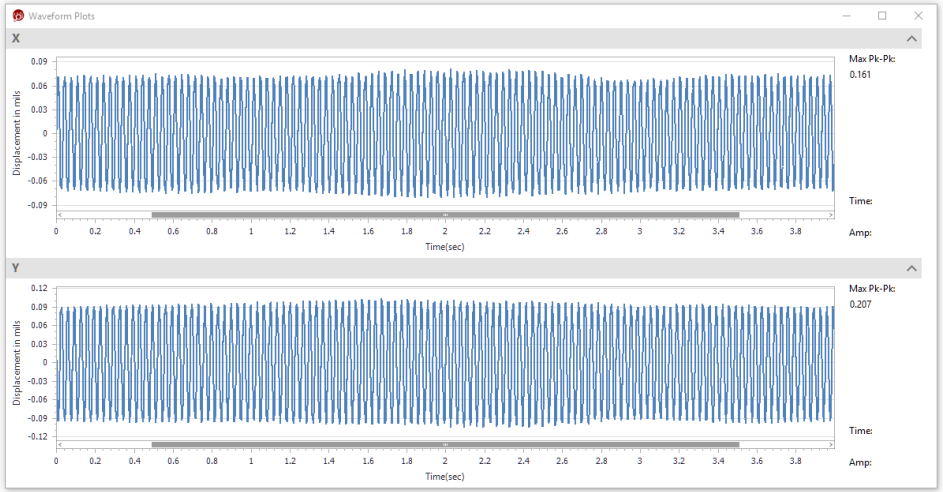
- Capture video data of an asset with simple to use camera and acquisition Software
- Press a button to process the video data
- Software outputs a Motion Amplification video
- **Millions of Data Points** and Information Across the Entire Asset

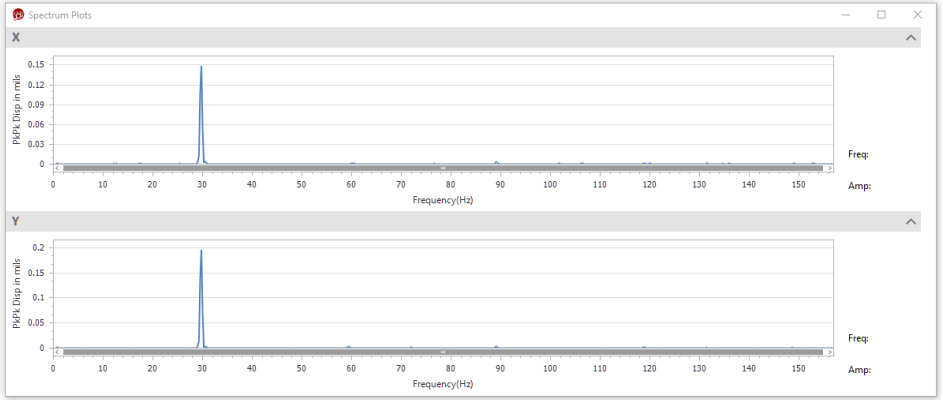


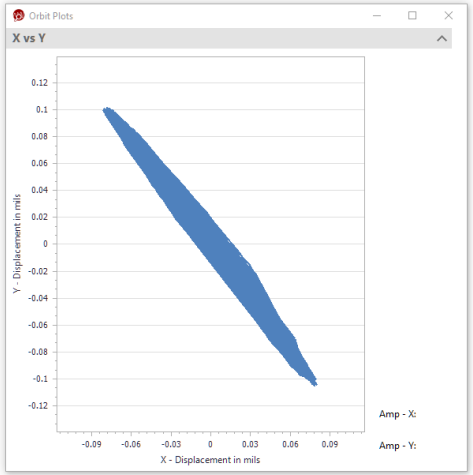
Simple as Point and Click

Then Amplify

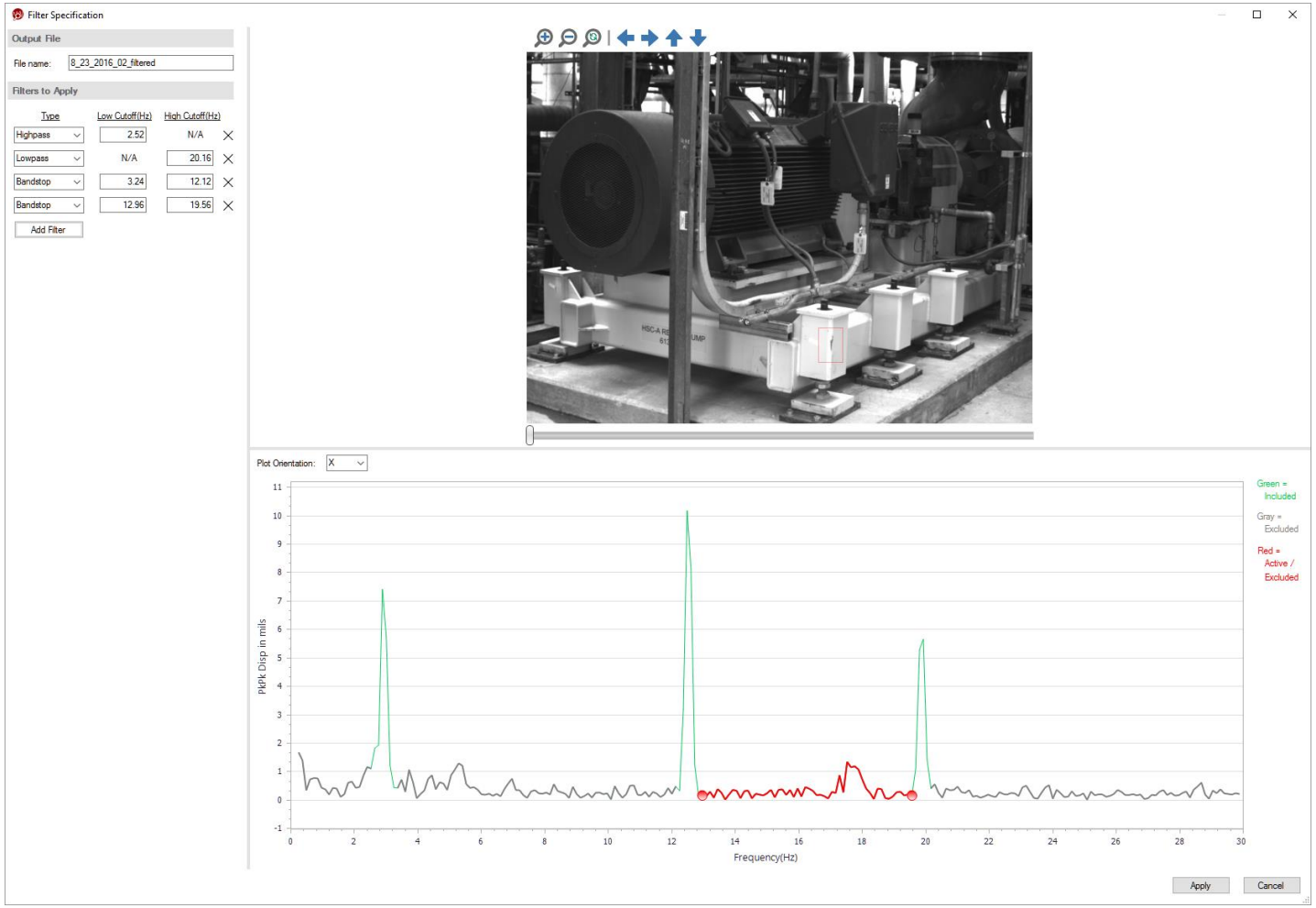
Displacement and Frequency



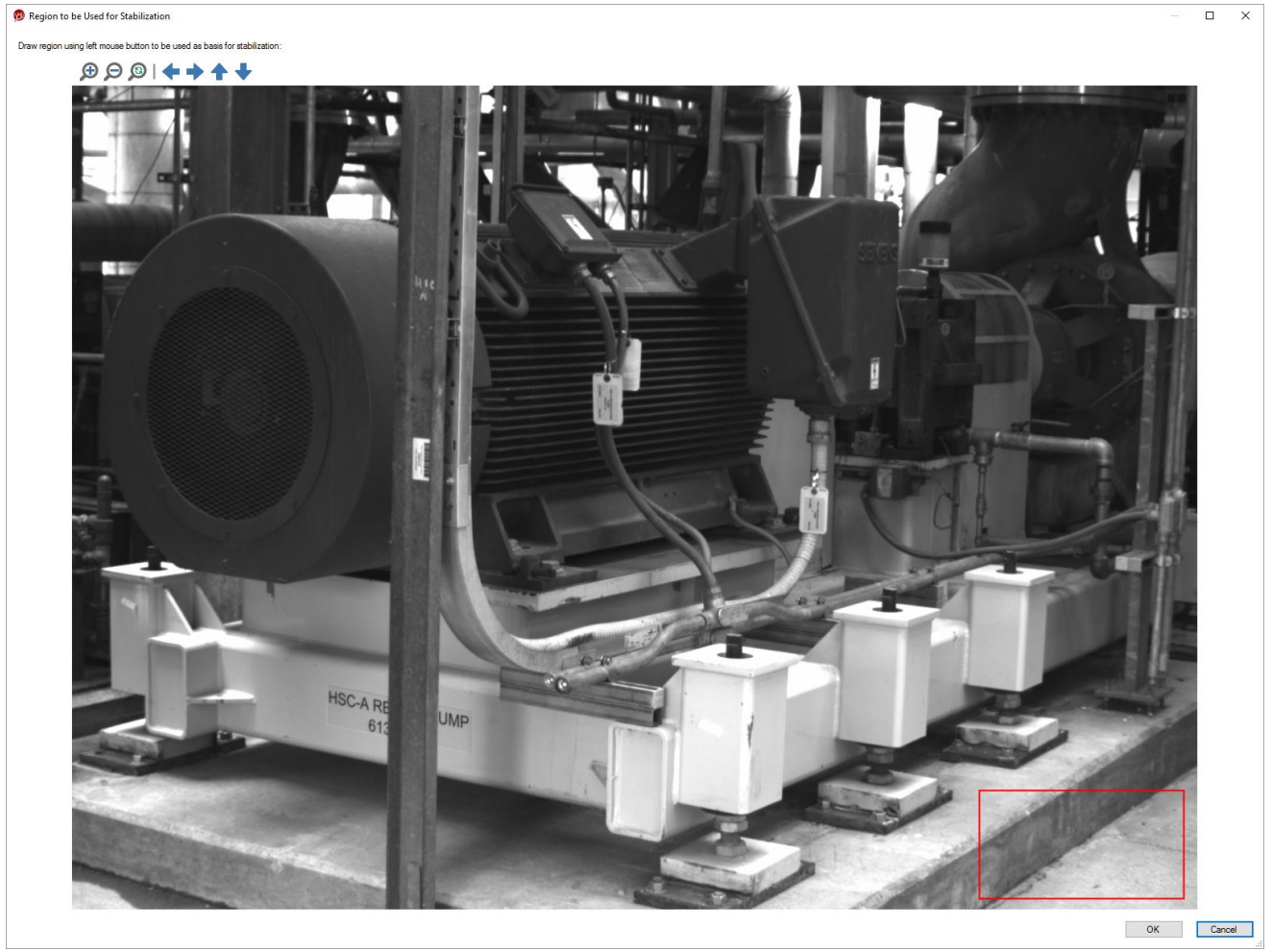




Filtering


Filter Specification
Output File
File name:
8_23_2016_02_filtered
Filters to Apply
Type
Low Cutoff(Hz)
High Cutoff(Hz)
Highpass
2.52
N/A
Lowpass
N/A
20.16
Bandstop
3.24
12.12
Bandstop
12.96
19.56
Add Filter
Plot Orientation:
X
PkPk Disp in mils
Frequency(Hz)
Green = Included
Gray = Excluded
Red = Active / Excluded
Apply
Cancel

Stabilization



Demo

Case Study - Stator Motor Pump

The Problem

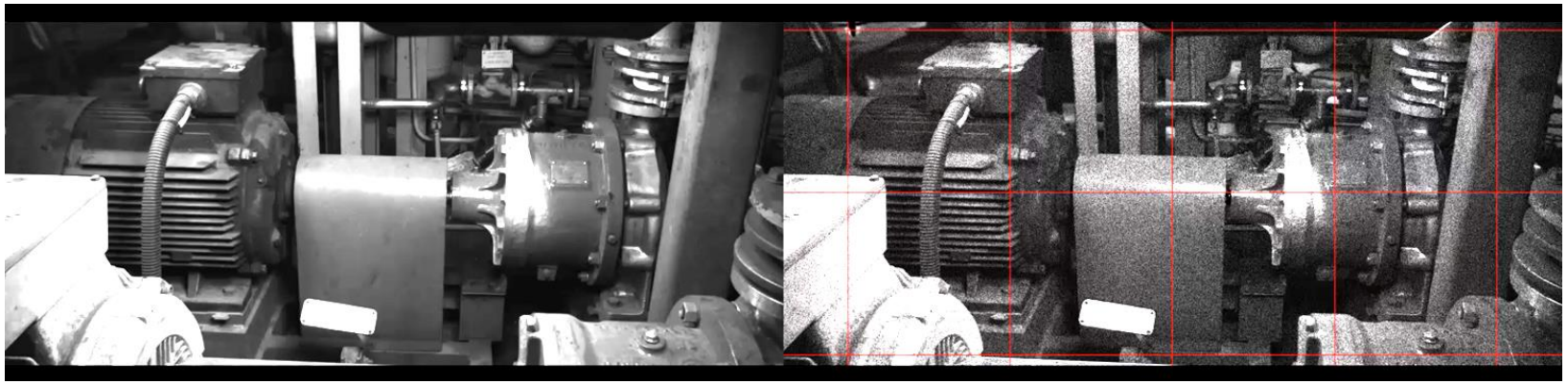
- **Company:** AGL Loy Yang
  Location: Latrobe Valley, Victoria, Australia Service **Provider:** Optical Motion Technologies (OMT)

- Excessive Vibrations relegated pump to be standby only
- $120,000 USD in repairs over 11 years
- 500 Man-hours expended
- Problem still existed
- Motion Amplification process completed in less than 1 hr.
- Root Cause Identified

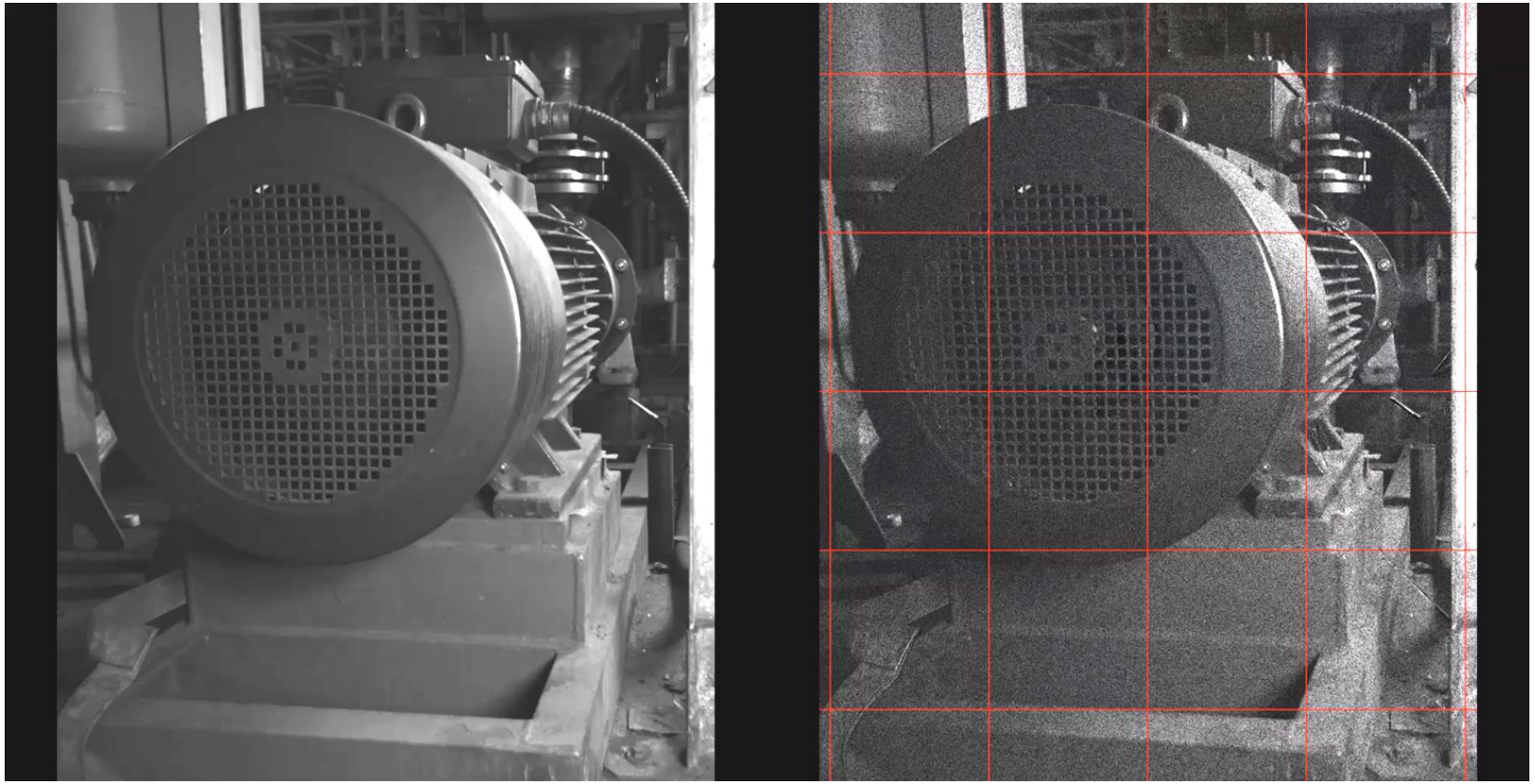
Case Study - Stator Motor Pump

- Motion Amplification revealed issues in the structural integrity of pump base frame
- Majority of Repair Complete– Client confident the problem is now understood
- Prior to Motion Amplification additional repairs were planned that would not have addressed the problem
- MA allows for a quick Root Cause look – quickly isolating issues

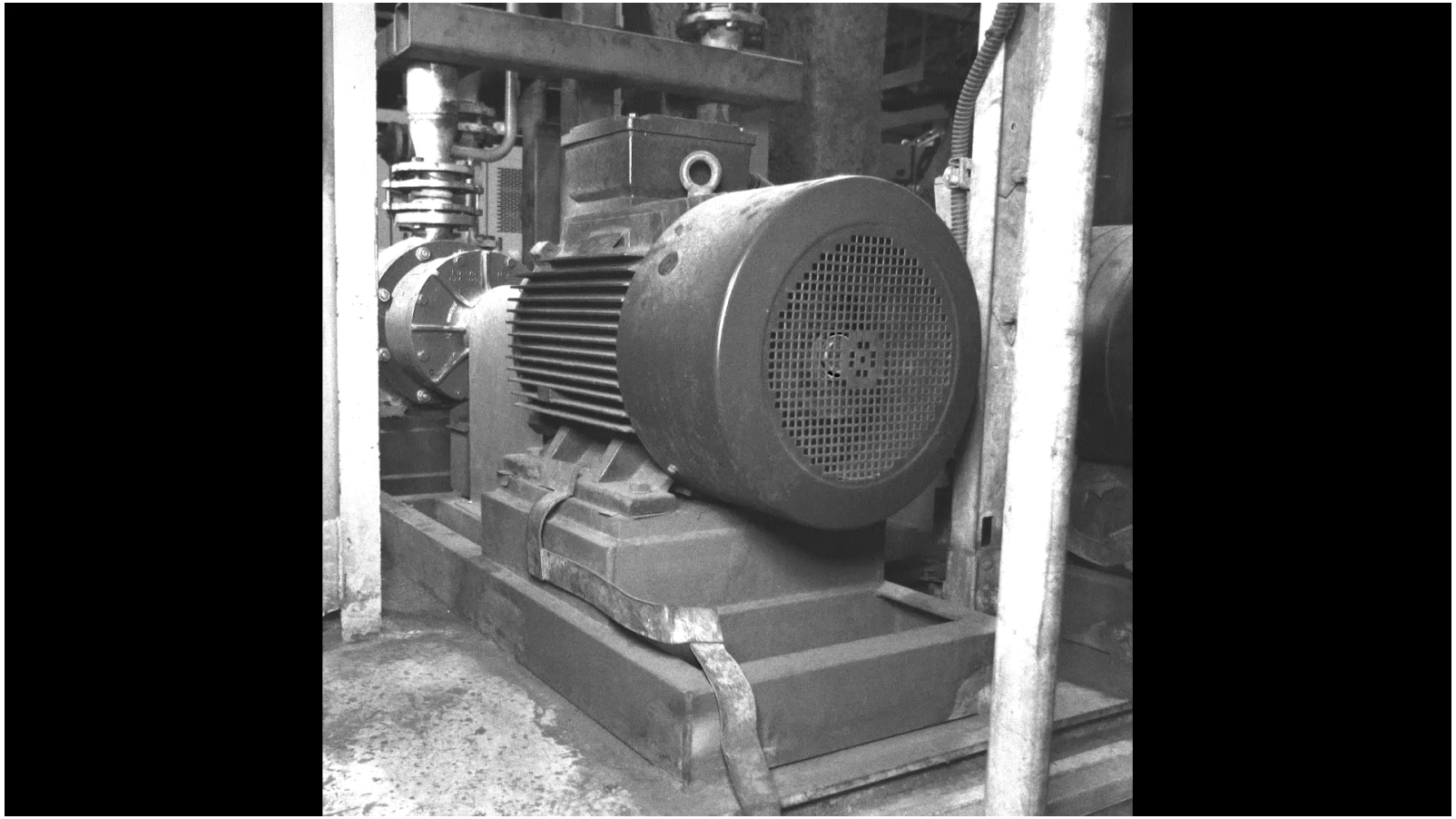
Stator Motor Pump



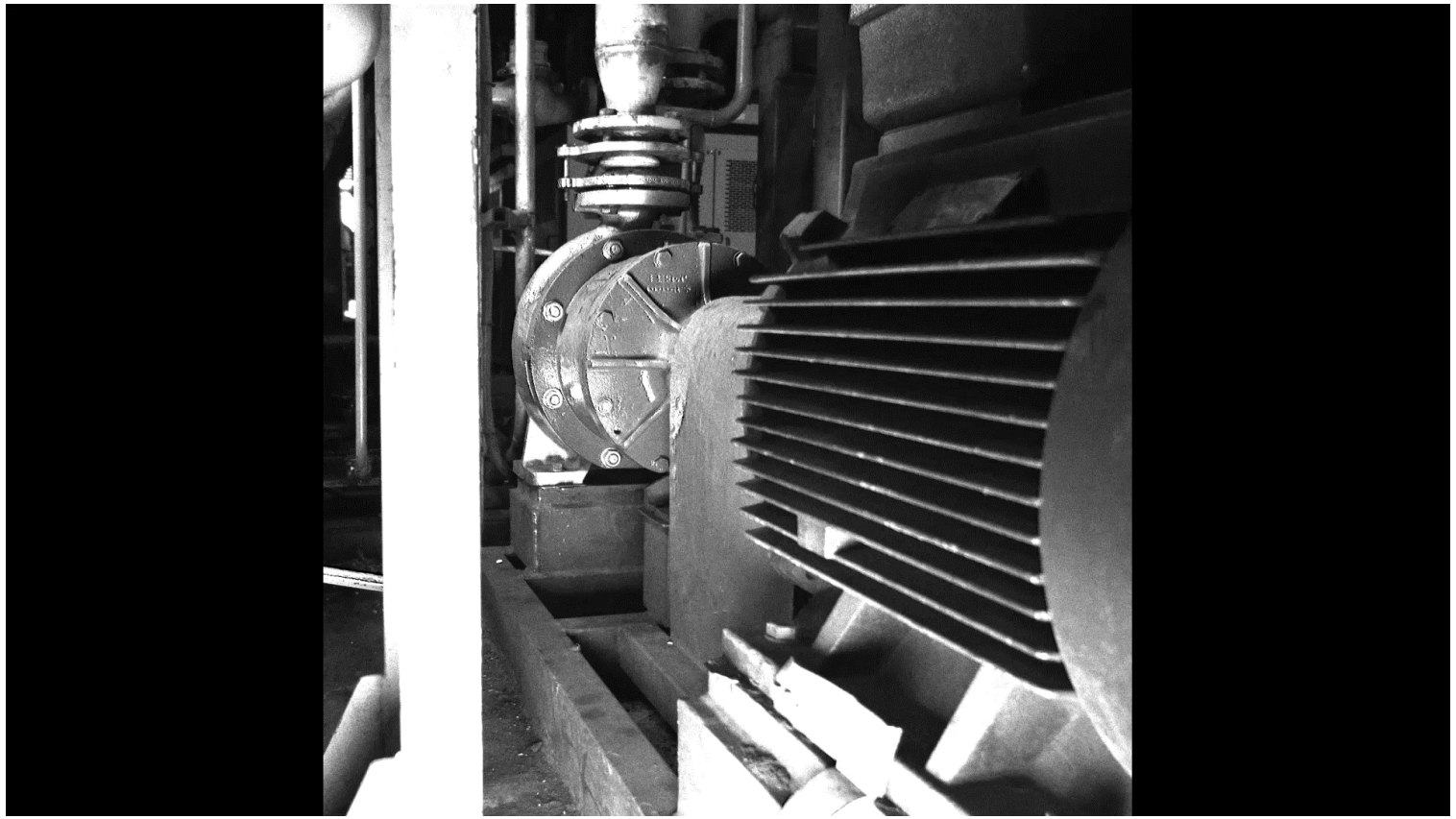
Stator Motor Pump



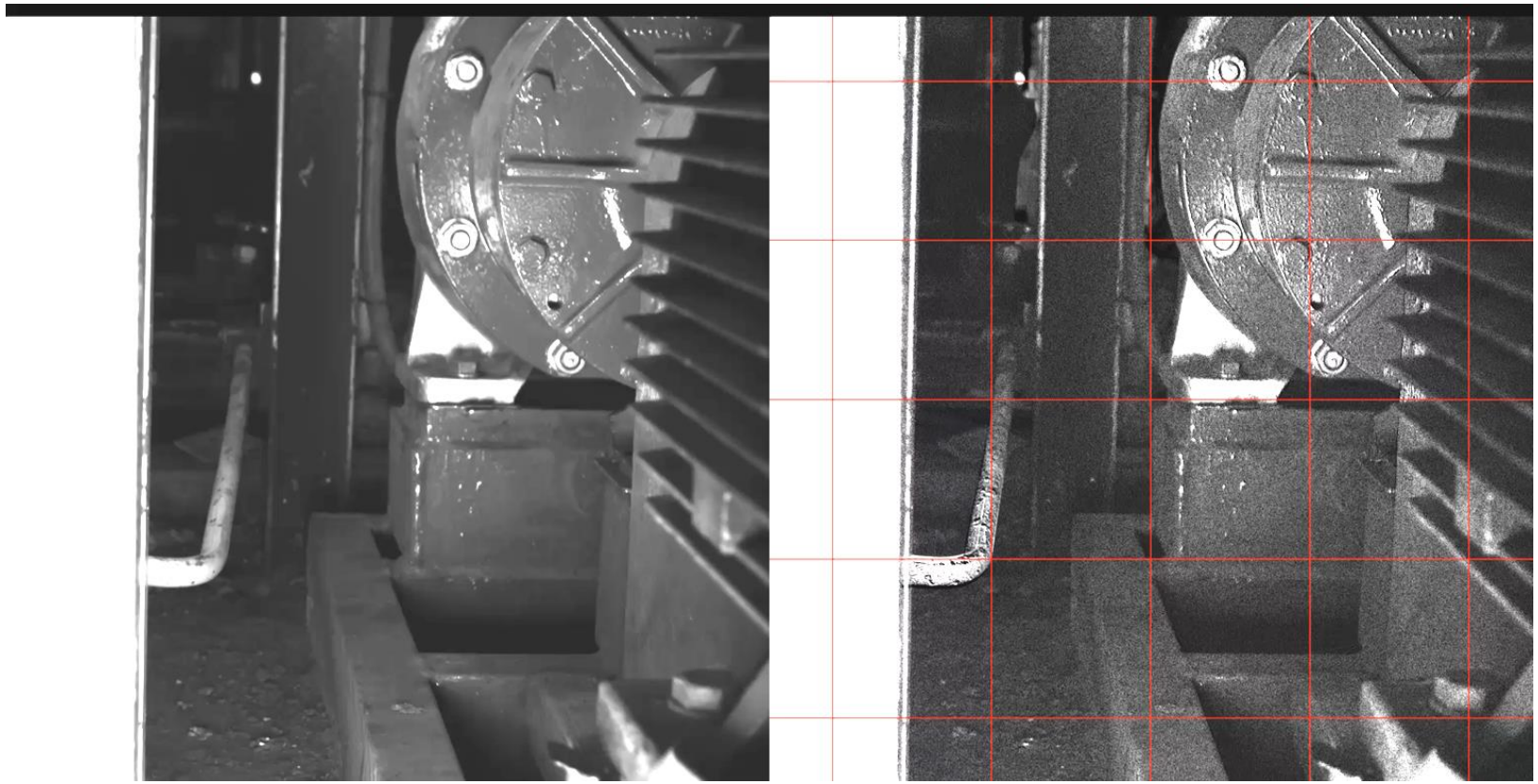
Stator Motor Pump



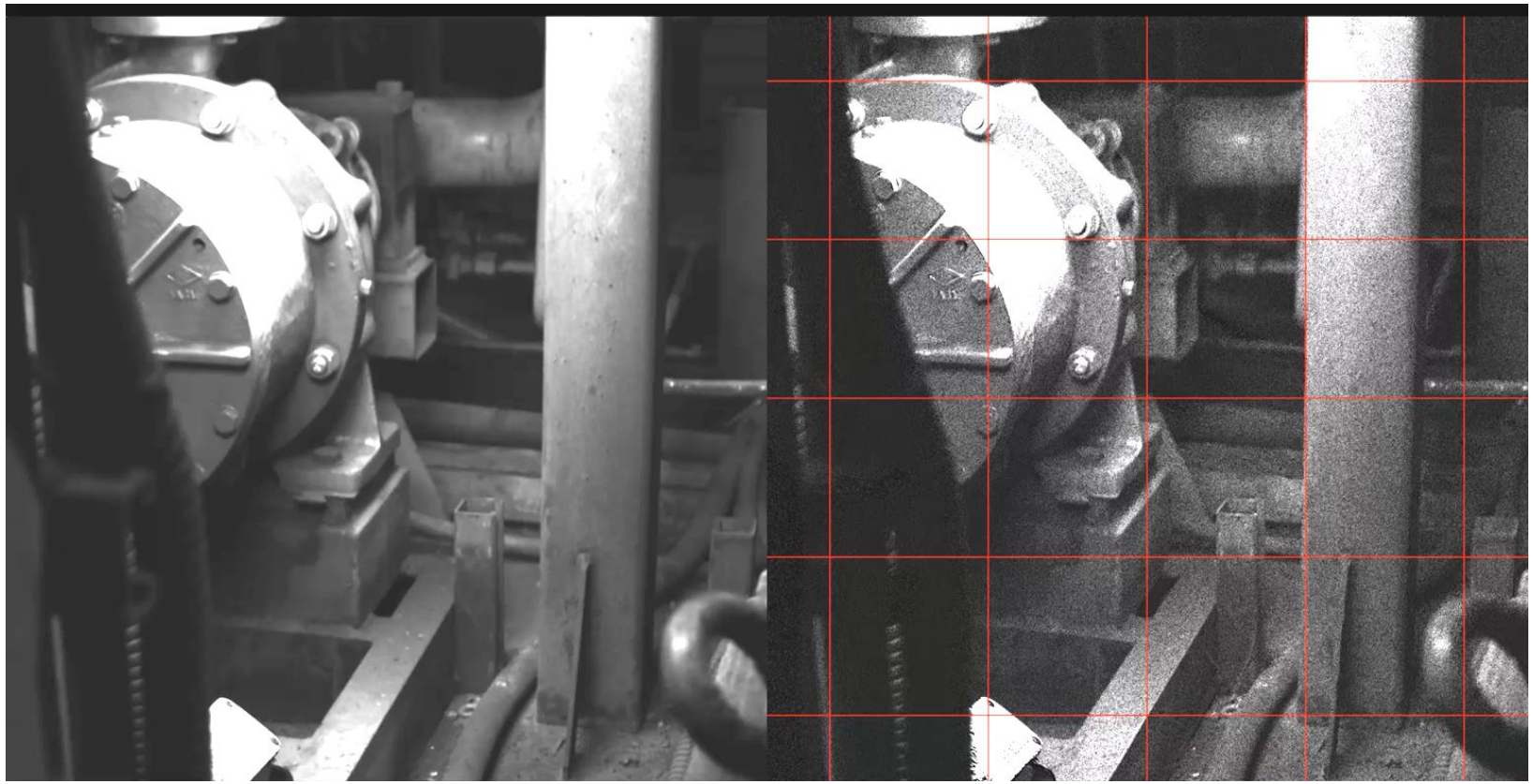
Stator Motor Pump



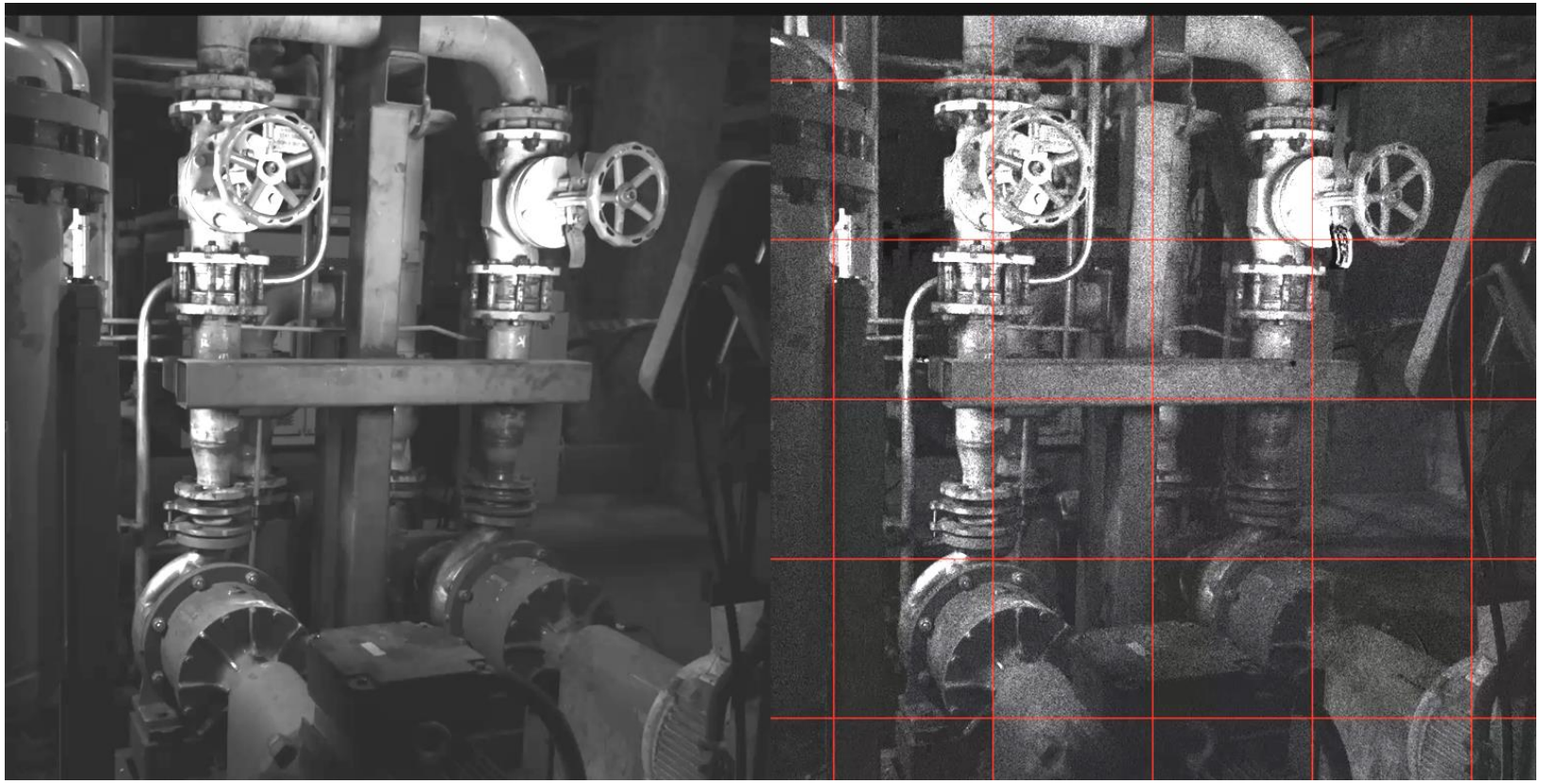
Stator Motor Pump



Stator Motor Pump



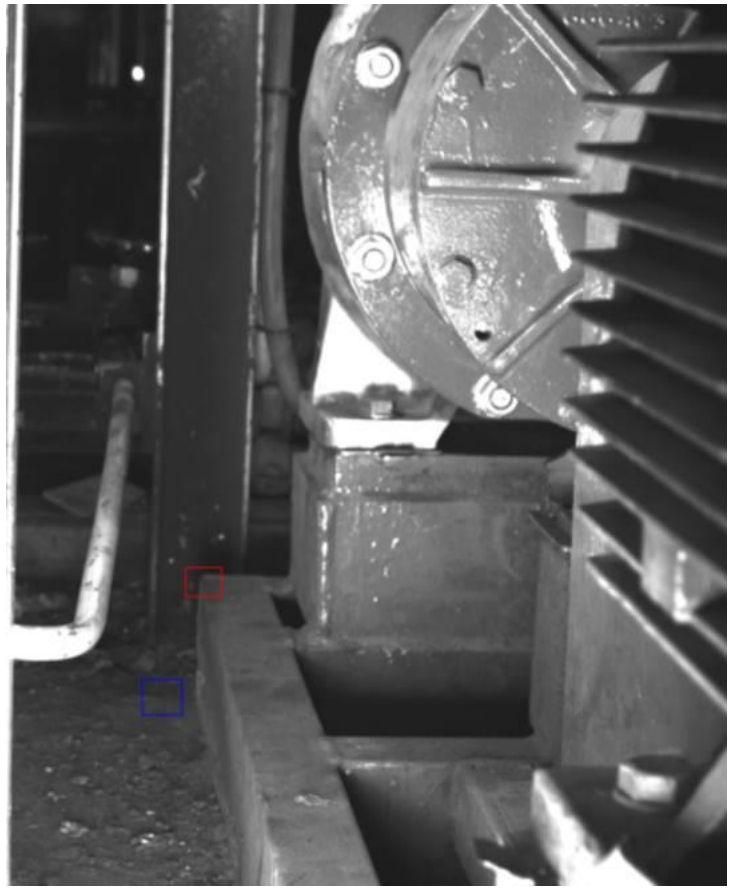
Piping Vibration



Case Study Results- Stator Motor Pump

"Seeing" the Solution

- Main indicator was that there was relative motion (soft foot) between the steel motor/pump frame and the common skid steel base plate
- "There was simply insufficient weld to secure the motor/pump frame properly to the skid base plate"
- ~2 mils Pk-Pk (Red Box on motor/pump frame) vs ~0.4 mils Pk-Pk (Blue Box on skid base plate)



Case Study Results- Stator Motor Pump

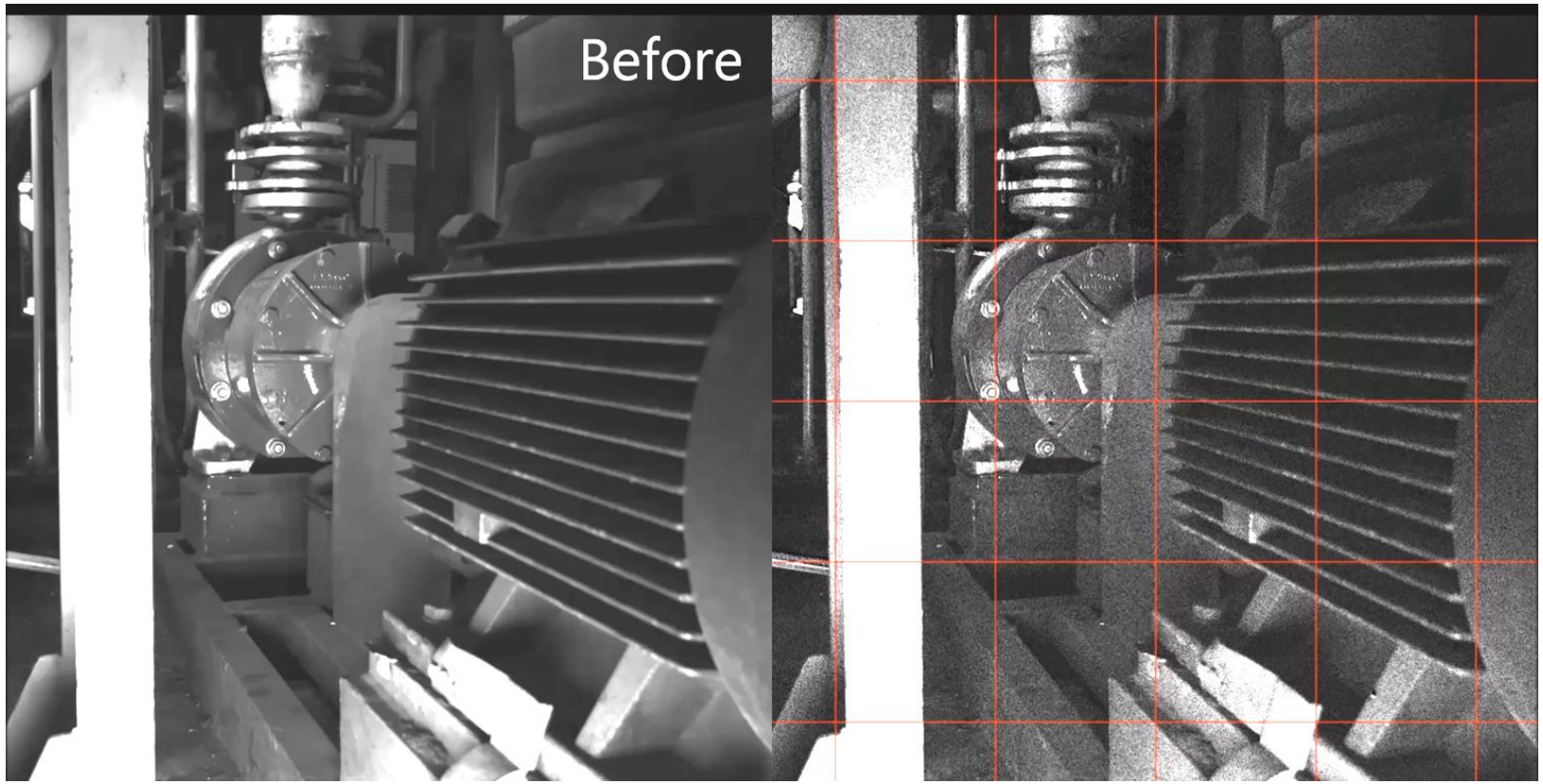
Recommendations and Conclusions

- Root Cause Issue Identified
- Fillet Welds applied to the interior base support
- Vibration reduced from 0.55 in/s to 0.15 in/s
- This is before realignment- expected to improve more.

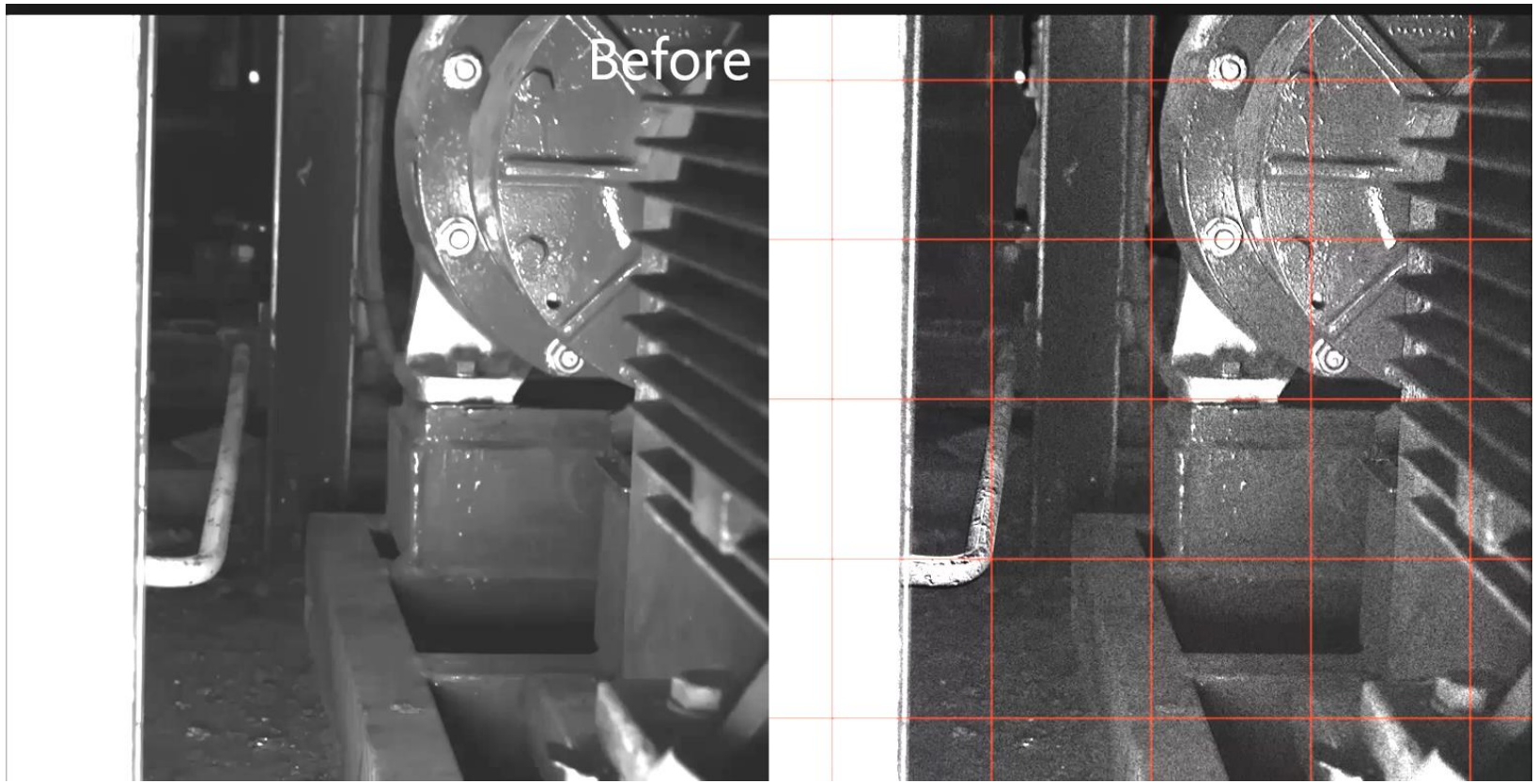
- *"This has proved to be a great assistance to rectifying a long-term plant issue. After only a short set up time it confirmed our vibration and phase measurement's without physically touching the plant."*

  Peter Fanning, Condition Monitoring Team Leader, AGL Loy Y

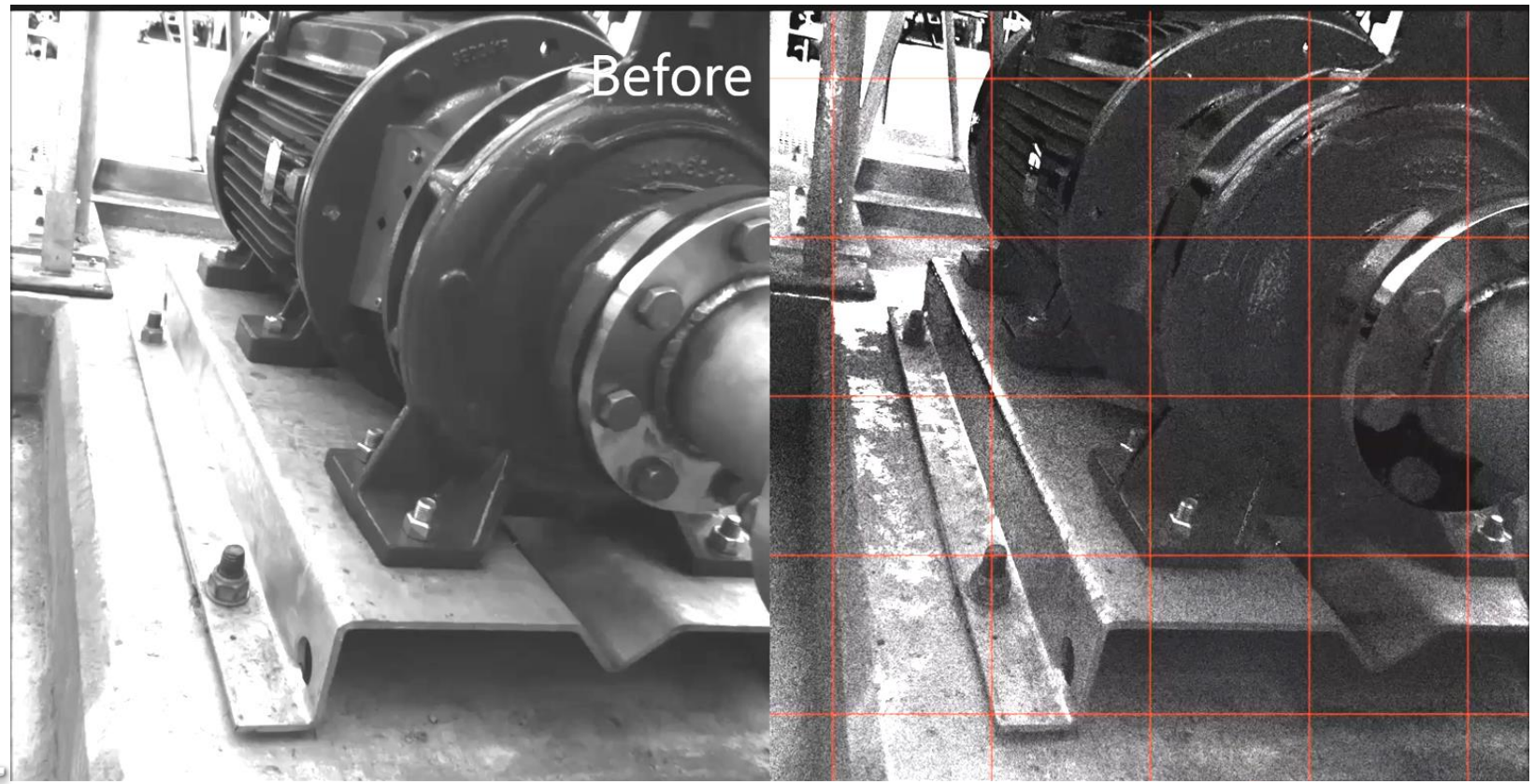
Before and After



Before and After



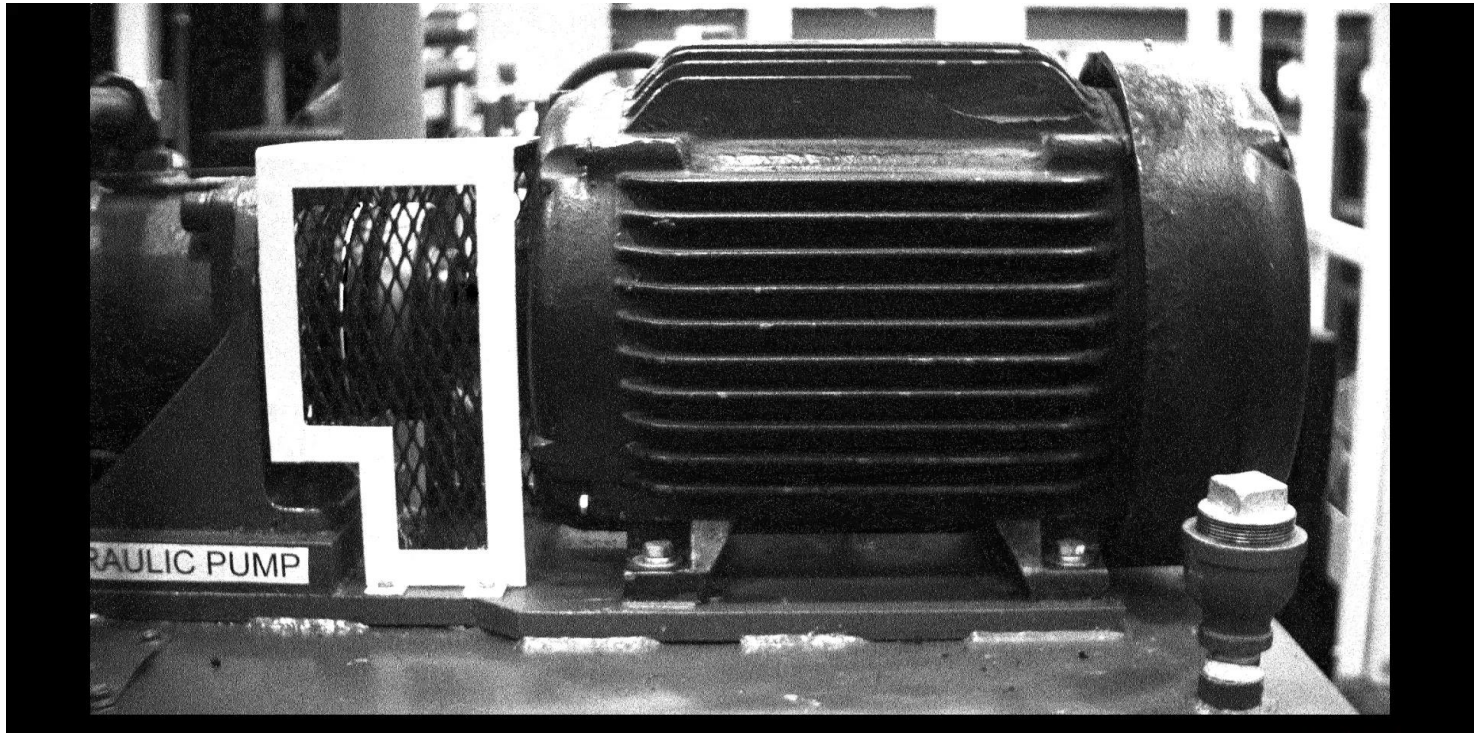
Before and After High Pressure Spray Pump



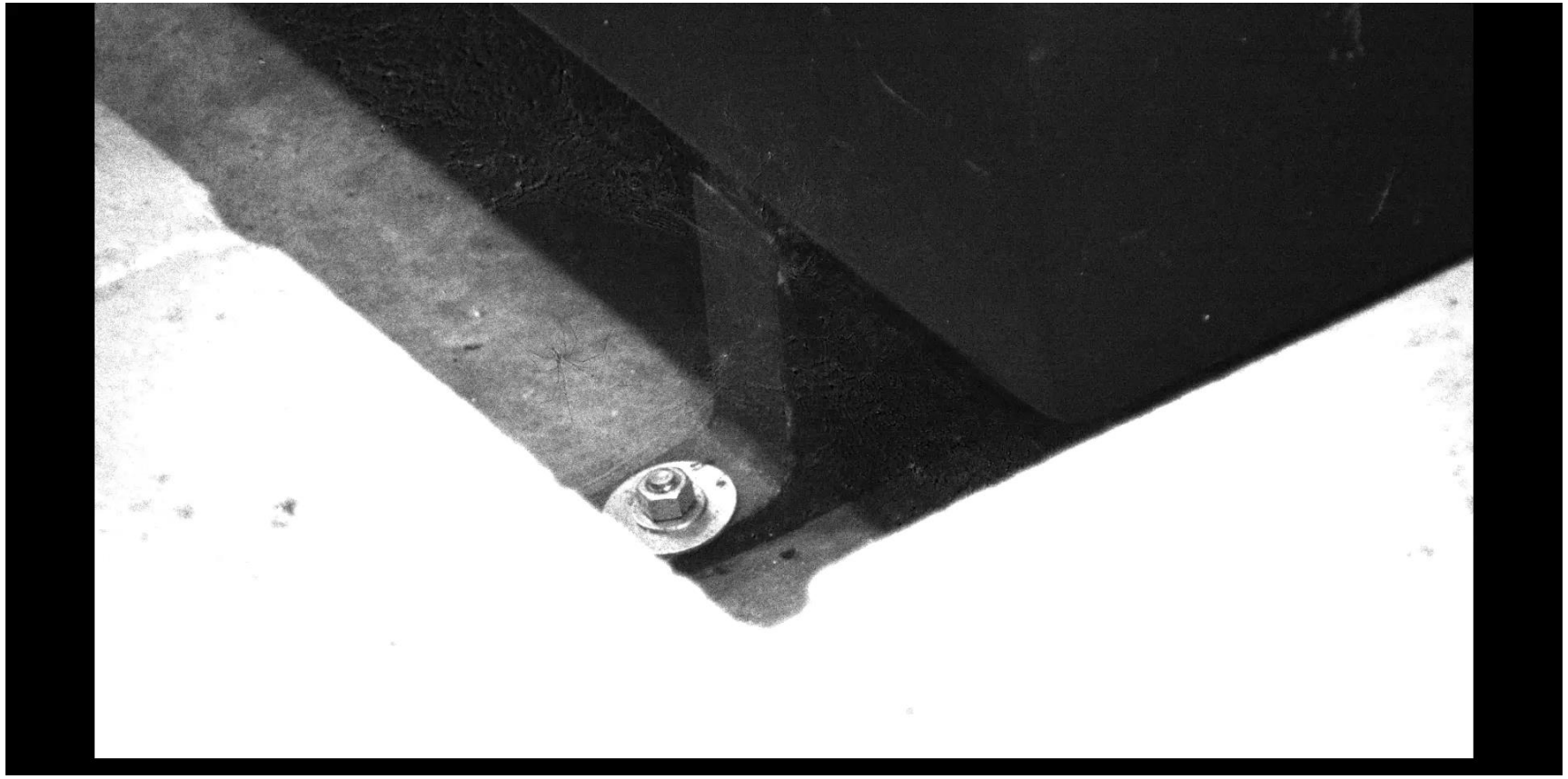
Case Study – Hydraulic Pump and Motor

- Operator knew of problem
- Could not determine root cause
- Motion Amplification process < 30 minutes.
- Issue identified as bolt drilled at an angle at install

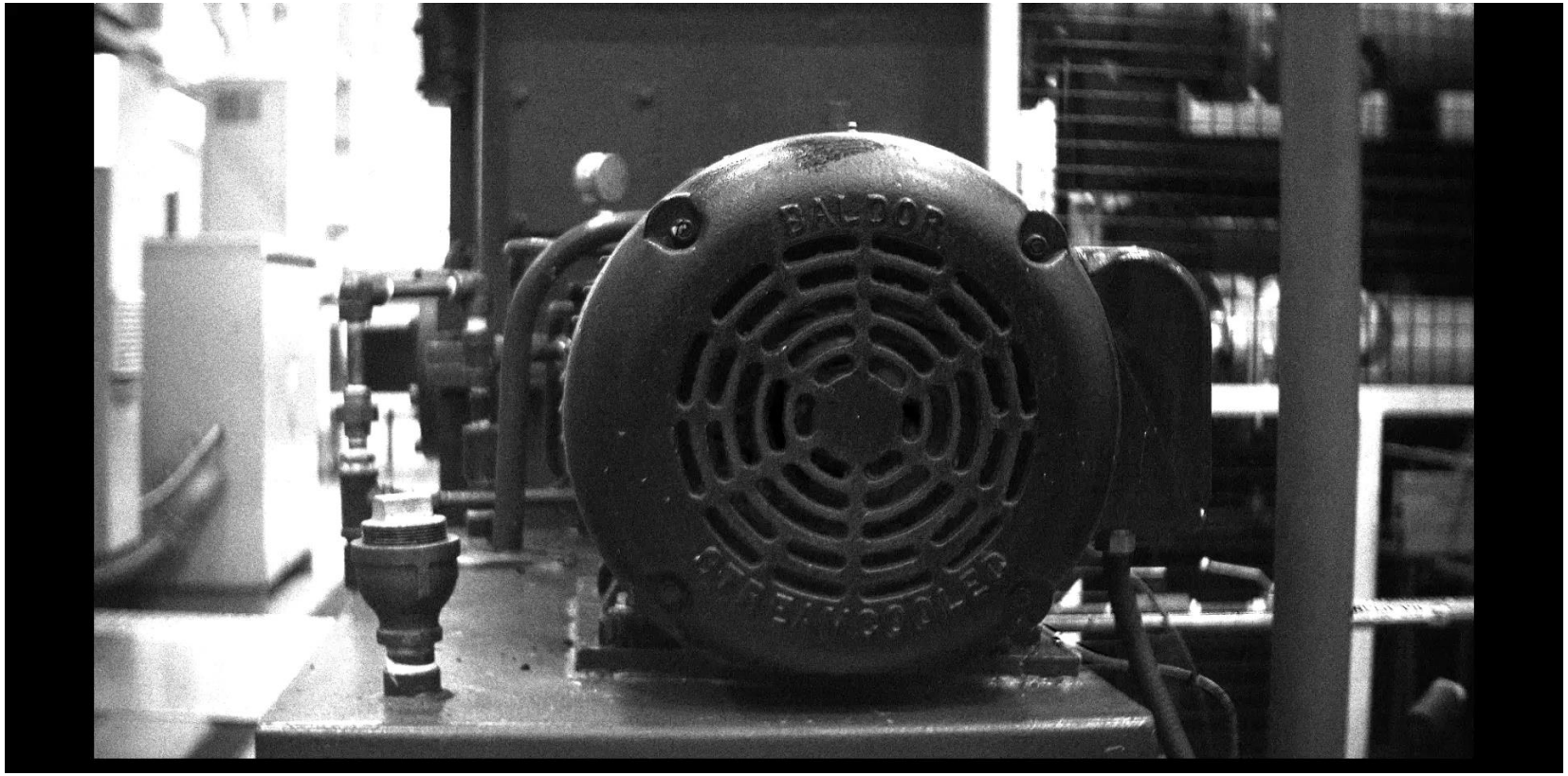
Entire View



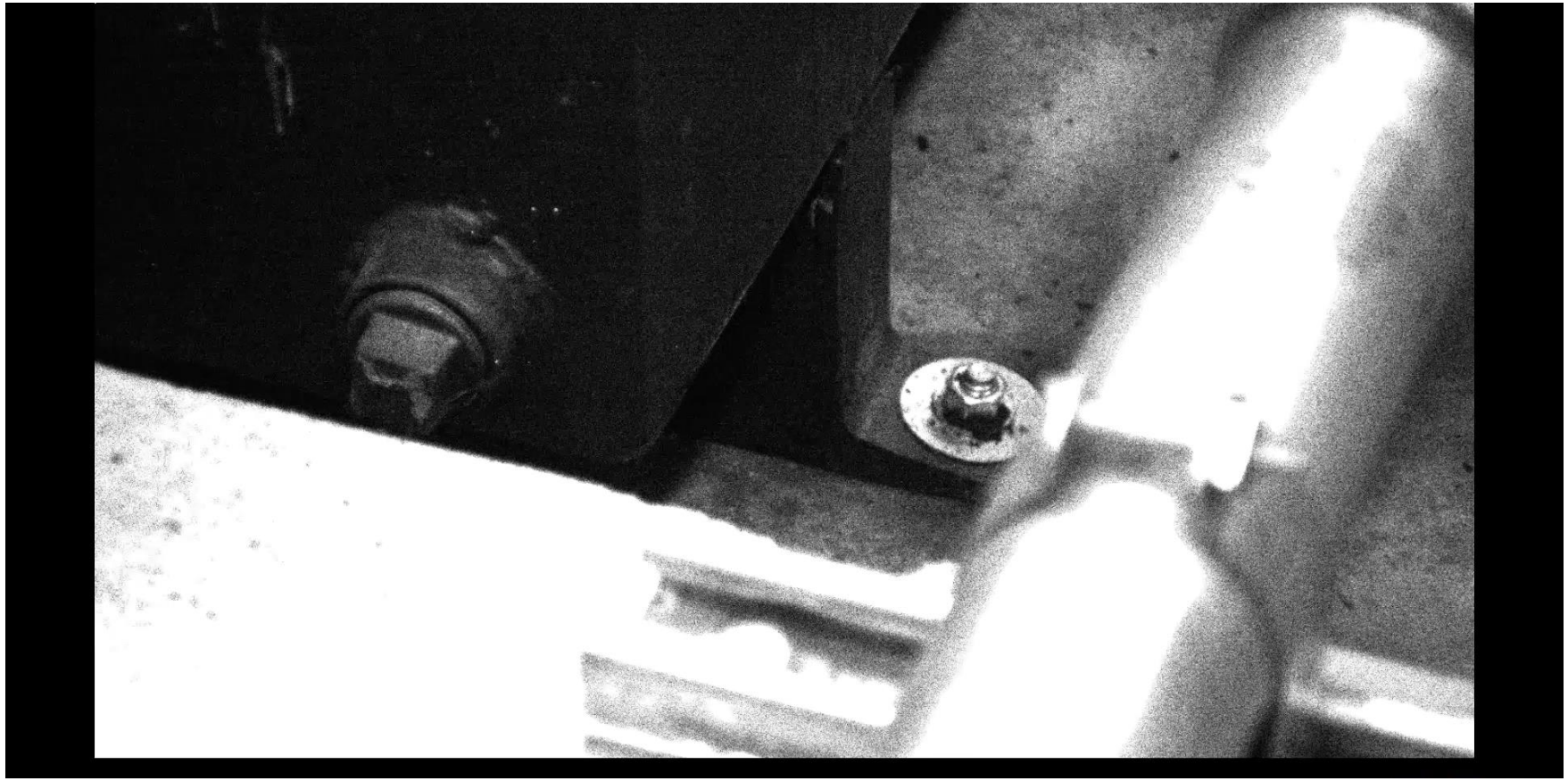
Isolate components



Isolate components



Hone in on problem



Pumps and Pipes